

# IOP Effects on Threatened and Endangered Species

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## 1. Introduction

This chapter is primarily focused on the hydrologic aspects of Interim Operation Plan (IOP) relevant to the endangered Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*). Only the sparrow is examined in detail. This detailed examination of the sparrow was provided to the National Park Service in a report entitled “The Cape Sable Sparrow under IOP”. Stuart L. Pimm, Duke University and Oron L. Bass, Everglades National Park authored the report.

Information was incomplete and/or time was insufficient to include the following other listed species thought most likely to be affected by IOP: the snail kite (*Rostrhams sociabilis plumbeus*), the wood stork (*Mycteria americana*), and the American crocodile (*Crocodylus acutus*). However, concerns regarding their recovery relevant to water management in the IOP project area are highlighted in boxes within the chapter. Also, ongoing and proposed research and monitoring activities for all four of the above listed species are described in this chapter. These activities are considered necessary for the continued evaluation of IOP effects on threatened and endangered species as well as the future evaluation of alternative water management scenarios.

## 2. The Cape Sable Seaside Sparrow: A synopsis of work from 1981 to 2000

Pimm et al. (2002) produced a book-length summary —*Sparrow in the Grass* — that reports data up to and including the 2000 field season. This introduction summarizes that book, which itself is a synopsis of a collection of scientific papers that appear in international, peer-reviewed journals. The book also includes extensive sections on the breeding biology of this bird and the risks it suffers from fire, flooding, and other factors. It constitutes the most significant reference for the following examination of the sparrow, being a recent compilation of the last decade’s research on this bird. The book is available at <http://www.env.duke.edu/faculty/pimm/cssshtml/10yearreport.html>

### 2.1 History

In 1918, A. Howell discovered the Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*), the last new “species” ever recorded in the continental United States. He found it in the saltmarshes of Cape Sable, the southeastern tip of the Everglades. This population must always have been tiny—there was never enough habitat on Cape Sable to support a viable population — and it was almost certainly only a peripheral and perhaps ephemeral subpopulation. The 1935 Labor Day hurricane, which devastated Cape Sable, almost certainly eliminated it.

In 1954, L. A. Stimson rediscovered the sparrow in the vast freshwater prairies of the Everglades. He realized then that the true range of the sparrow must cover an area much larger than the scattered saltmarshes near the coast. In fact, the distribution of the sparrow

belies its appellation of “seaside”, being found as far as 40 km inland from the Gulf of Mexico. There is no evidence that it only recently moved into freshwater marshes. Stimson understood that the sparrow has likely been a freshwater sparrow over geological time spans.

The Cape Sable seaside sparrow is a medium-sized sparrow that today occurs in Miami-Dade and Monroe Counties of South Florida. This non-migratory sparrow has the most restricted range of any bird in North America and occurs almost exclusively within the boundaries of Everglades National Park and Big Cypress National Preserve.

The extent and distribution of the Cape Sable seaside sparrow has changed dramatically in the last century. South Florida has the largest expanse of marl prairie, the preferred habitat of the sparrow. These prairies are naturally inundated on average from 3 to 7 months per year (approximately July through January), but are dry during the sparrow’s breeding season (March through June). This expanse of potential sparrow habitat has suffered two major assaults within this century: drainage and development.

In South Florida, marl prairies have been lost to agricultural and urban land uses and are no longer suitable for the sparrows. Moreover, the construction of canals throughout the Everglades ecosystem has altered the hydrological regime of much of the remaining marl prairies. Much of the remaining prairies are rendered unsuitable for the sparrows because changes in the hydrology have initiated changes in dominant vegetation. Areas that have been flooded for longer periods than are normally appropriate for marl prairies are shifting from wet grassy prairies to sawgrass marshes. Prairies flooded for shorter periods of time are experiencing the spread of woody plants.

Male Cape Sable seaside sparrows occupy and defend their territories during the breeding season. Breeding activity, particularly singing behavior by males, appears to decrease with increased surface water conditions. Nests are cups constructed of grasses and are on average approximately 4 inches above the ground. When water levels exceed about 4 inches, nesting activities cease.

The Cape Sable seaside sparrow was among the first group of species listed as endangered by the U.S. Fish and Wildlife Service on March 11, 1967. The sparrow was listed because of its limited distribution and threats to its habitat posed by large-scale conversion of land in southern Florida to agricultural uses. Surveys of the sparrow, employing helicopters to ferry observers to its remote locations, began with Harold Werner in 1974. In 1981 the first range-wide survey was undertaken. This was repeated in 1992, and range-wide surveys have continued every year since. The surveys show that sparrows are found in a set of populations (A through F) separated to various degrees by unsuitable vegetation (Figure 1 – substitute Brandon’s figure for this figure).

## **2.2 Sparrow population numbers**

The sparrow was surveyed in 1981, every year since 1992, twice in 2000, and in 2003 some key areas on a finer scale than the normal one km by one km grid. Over this period,

there have been substantial changes in many of the six populations. In 1981, population A inhabited the marl prairies west of Shark River Slough, interlaced between drier, shrub-dominated areas, and wetter, sawgrass-dominated areas. It extended into Big Cypress National Preserve, and held an estimated 2688 individuals. Population B held 2352 individuals near the center of Everglades National Park. Population E, just north of B, held 672 sparrows, while C and D, located along the Park's eastern boundary, held about 400 individuals each. F was the smallest population at 112 individuals. The subsequent changes summarized below are many and complex.

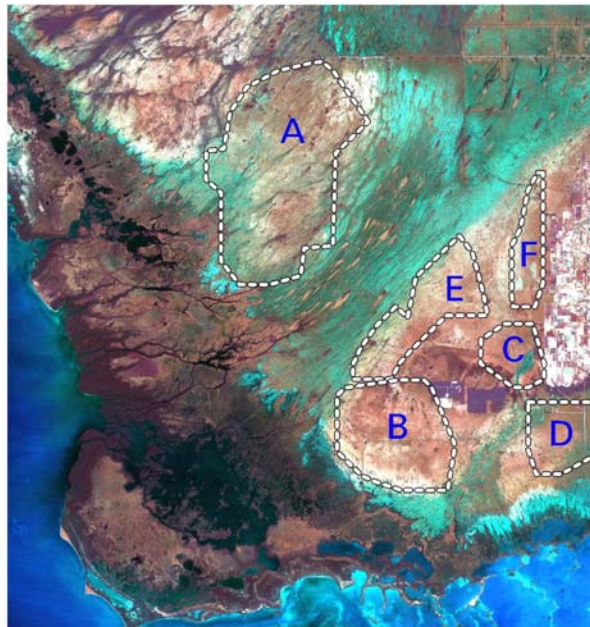


Figure 1. The location of the six populations of the Cape Sable seaside sparrow.

Population A suffered the most dramatic sparrow population change observed. The population decreased by 84% from 1992 to 1993 — a decline from over 2600 birds to just over 400 birds. In 1995, biologists found that the population had decreased again, to just over half of the 1993 abundance. It has remained low ever since. The important ecological question is whether a decline of this size is remarkable given the normal year-to-year variation in population densities found in comparable species. Pimm et al. (2002) determined that it is not only remarkable, but also unprecedented.

In Pimm et al. (2002), the authors discussed the population changes observed in population A since the flooding events of 1993-1995. Population A is the population most severely impacted by water management practices. These changes in population A are central to the discussion of IOP and are discussed later in this chapter.

Population B has remained more or less constant, the range in numbers being encompassed by the two survey estimates in 2000.

The two northeastern populations C and F held an estimated 544 birds in 1981; since 1992, the estimate has never reached 200. Pimm et al. (2002) concluded that the underlying mechanism is fire. (With one caveat: a small area in C, south of pumping

station S-332 and downstream of Taylor Slough bridge, has changed from muhly-dominated prairie to sawgrass marsh as a consequence of higher water levels. Though a small area, it is very well studied.).

Population D held 400 birds in 1981, numbers that have not been seen since. This area, like population A, has suffered high water levels that have precluded birds from nesting there successfully. This population is also central to the discussion of IOP and it will be discussed in more detail later.

Population E has a particularly complex history. It is best understood by splitting the population into two pieces: E (North) and E (South). Although the numbers are small, it appears that E (South) held roughly 300 birds in 1992, but after that there were only sporadic sightings until 2000 and 2001, when the area may have held > 100 birds. These numbers add to the evidence for flooding harming the birds (Pimm and Bass, 2003).

Population E (North) had relatively low numbers in 1992 through 1996, but since 1997 has held at least 600 birds. It is possible that this increase is a recovery from the 1989 Ingraham fire that burned this area.

These population changes summarized above have legal ramifications, because the Endangered Species Act prohibits actions that will harm endangered species, both directly and indirectly (through changes to their habitats). The following section summarizes explanations for these changes and identifies what is known about the factors that caused them.

### **2.3 Causes of population changes**

With so many events occurring in more or less the same timeframe, biologists must be careful in assigning cause and effect. For a detailed discussion the reader is referred to the body of work encompassed in Pimm et al. (2002). Some of the hypotheses that have been suggested and discussed include:

- *The sparrows did not disappear; biologists just haven't been looking for them in the right places.* This is the least credible hypothesis. It has never been accompanied by plausible suggestions of where the missing birds may be hiding.
- *Population fluctuations are a normal part of the ecology of all small birds, especially those with small, restricted populations.* The changes in bird numbers observed are not only statistically significant, but fall outside the range expected for normal populations.
- *Flooding is a natural part of the Everglades hydrology. There have always been wet years and dry years.* This may be correct, but the flooding that has caused the population declines is the result of deliberate water management decisions. The flooding is far in excess of what would be expected from natural variability.

- *Flooding causes only temporary damage to the habitat on which the sparrows critically depend.* Pimm et al. (2002), reject this hypothesis and demonstrate that the habitat has been modified over the long term.
- *Colonists from the healthy eastern populations will quickly restore the western population.* This is not considered a credible hypothesis (Pimm et al. 2002). The birds are highly philopatric, the distances between populations are great, and the hypothesis does not address whether the eastern populations have a sufficient excess of individuals to export. Most telling of all is that the western population has not, in fact, recovered.
- *The eastern areas suffer from a much higher frequency of fires, mostly anthropogenic, accounting for repeated extirpations in population F and the upper part of population C.* Pimm et al. (2002) have confirmed this hypothesis.
- *Habitat in the lower part of population C has been permanently altered by the change in water regimes due to pumping of water into Everglades National Park, just north of Taylor Slough Bridge.* This has been confirmed by detailed vegetation analyses. A similar hypothesis seems to be the best explanation for the changes in population D.
- *Three years of almost continual flood conditions caused significant damage to sparrow habitat that is slowly regaining some of its former extent.* Pimm et al. (2002) have confirmed this hypothesis.
- *Sparrow numbers are recovering slowly, as their breeding ecology suggests.* Only when the great majority of the nesting pairs in a population can all rear two or more broods can the population grow significantly from one year to the next. The observed failure of population A matches what biologists expect from this demographic analysis.

Based on these conclusions and the census data above, increasing concern was expressed by the U.S Fish and Wildlife Service on the impacts of the Everglades National Park Experimental Water Deliveries Program on the continued existence of the sparrow and its designated critical habitat. The population census data from 1995 and other available scientific information led the U.S Fish and Wildlife Service to conclude in its Biological Opinion (BO) of October 27, 1995 that Test Iteration 7 was likely to jeopardize the continued existence of the sparrow. The BO also instructed the Corps to develop a Remedial Action Plan (RAP) as part of the reasonable and prudent alternative to avoid jeopardy.

Due to disagreements on the content of the RAP, the plan floundered for years until the U.S Fish and Wildlife Service, alarmed by the 1997 sparrow census data and the continued population declines, asked the Corps to reinstate consultation in November 1997. The Final BO resulting from this reinstated consultation was delivered to the Corps on February 19, 1999. The 1999 BO affirmed the previous BO and concluded that

Iteration 7 of the Experimental Program was likely to jeopardize the continued existence of the sparrow and to destroy and adversely modify the sparrow's designated critical habitat.

In brief, the U.S Fish and Wildlife Service's Biological Opinion argues that decisions by water managers had led to repeated flooding of the western population A during its breeding seasons and long-term changes to its habitat as a consequence of the unnatural high water levels. Concomitantly, eastern populations occupied habitats that were unnaturally dry and thus subject to periodic fires.

Work since the 2000 field season supported and refined the conclusions on which the Service's Biological Opinion is based. For example, a fire burned through part of population E in the 2001 breeding season. Work by Professor Julie Lockwood (Lockwood, in preparation) confirmed that sparrow breeding numbers are severely depressed for at least two years post-fire.

As part of the BO, the U.S Fish and Wildlife Service also provided the Corps with the Reasonable and Prudent Alternative to the experimental program that will avoid jeopardizing the Cape Sable seaside sparrow. This reasonable and prudent alternative stipulated the Corps to complete the following operational modifications for the Experimental Program:

1. By March 1, 1999, the Corps must prevent water levels at Everglades National Park hydrological monitoring site NP205 from exceeding 6.0 feet-ngvd for a minimum of 45 consecutive days between March 1 and July 15. According to the U.S Fish and Wildlife Service BO, this would provide water levels sufficient to allow completion of one nesting cycle in approximately 40 percent of the sparrow habitat in Subpopulation A.
2. By March 1, 2000, the Corps must prevent water levels at Everglades National Park hydrological monitoring site NP205 from exceeding 6.0 feet-ngvd for a minimum of 60 consecutive days between March 1 and July 15. According to the U.S Fish and Wildlife Service BO, this would provide water levels sufficient to allow completion of two nesting cycles in approximately 40 percent of the sparrow habitat in Subpopulation A.
3. By March 1, 2000, the Corps must implement actions that would produce hydroperiods and water levels in the vicinity of Cape Sable seaside sparrow populations C, E and F, equal to or greater than those that would be produced by implementing the exact provisions of Test 7, Phase II as described in the Final EA for Test 7 (Corps 1995). This action must be continued until implementation of the Modified Water Deliveries Project.
4. By March 1, 2000, the Corps must ensure that at least 30 percent of all regulatory releases (the supplemental component of the rainfall plan water deliveries)

crossing Tamiami Trail enter Everglades National Park east of the L-67 extension canal.

5. By March 1, 2001, the Corps must ensure that at 45 percent of all regulatory releases (the supplemental component of the rainfall plan water deliveries) crossing Tamiami Trail enter Everglades National Park east of the L-67 extension canal.
6. By March 1, 2002, the Corps must ensure that at 60 percent of all regulatory releases (the supplemental component of the rainfall plan water deliveries) crossing Tamiami Trail enter Everglades National Park east of the L-67 extension canal.
7. The Corps must take all actions necessary to complete full operational implementation of the Modified water deliveries Project by December 2003.

Both the Interim Structural and Operational Plan (ISOP) and the Interim Operational Plan (IOP) are water delivery plans formulated to specifically address the concerns for the Cape Sable seaside sparrow as stated in the original and subsequent versions of the U.S Fish and Wildlife Service BO. The intended purpose of these plans is to implement water-management actions consistent with the specific provisions of the Reasonable and Prudent Alternative to avoid jeopardy to the Cape Sable seaside sparrow and not destroy or adversely modify designated critical habitat. Details of the ISOP and IOP water management plans can be found elsewhere in this document.

Changes in water deliveries as a result of implementing ISOP/IOP and their consequences since the Biological Opinion constitute the remainder of this discussion of the sparrow.

## **2.4 A comparison of the years 1996 through 1999 with the years 2000 to 2003. *The Western Population (A)***

### ***2.4.1 A sparrow's view of hydrology***

Given the importance of population A, being the population most impacted by water management, the water levels within population A will be discussed first. Water monitoring station NP205 provides the best record of water levels for this population. The dynamics of NP205 have been discussed elsewhere (Pimm et al. 2002).



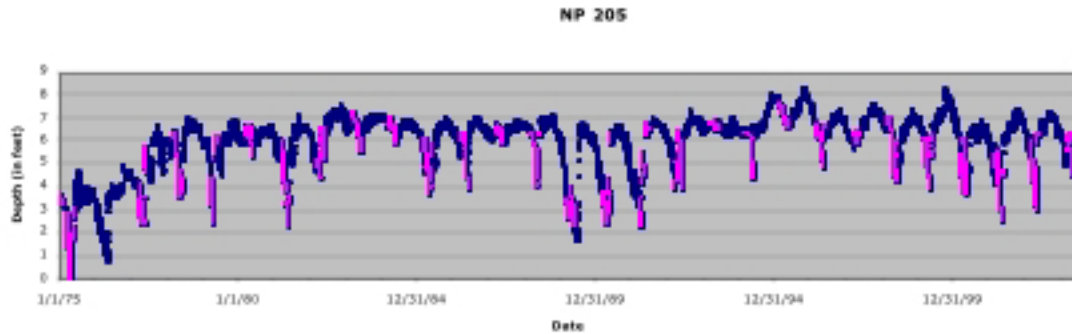


Figure 2. Daily water levels at NP205; pink points are those during the breeding season, taken as the 90 days starting March 15<sup>th</sup>.

Water levels at NP205 from 1975 to 2003 have the long-term trends expected for climatic variables (and the species that depend on them.) There were dry years in the late 70s to early 80s, when breeding season water levels were often under 6 feet (the approximate height of NP205), followed by wetter years in the middle 80s. The late 80s to 1992 were usually dry, while the years from 1993 to 1995 were exceptionally wet, a condition exacerbated by unprecedented breeding season water-releases across the S12s.

The period of interest compares 1996 to 1999 (inclusive) to 2000 to 2003 (inclusive) and involves the 90 days following March 15<sup>th</sup> each year (Figure 3a, b). The figures show the same data as in figure 2, though in more detail. Also relevant are rainfall events, for these elevate the water levels considerably. Generally, heavy rains (defined as totals of >1-5 inches) are spread over two days. However, in some cases, heavy rain continued over three or four days. The figures also show these events and their durations. Water levels at NP205 remained above 6 feet for all but about 20 days of 1996, all of 1997, and about 30 days in 1998 (ending with a 2 day rainfall total of 2.72in in late May). In contrast, in 1999, water levels were below 6 feet from March 15<sup>th</sup>, until mid-May.

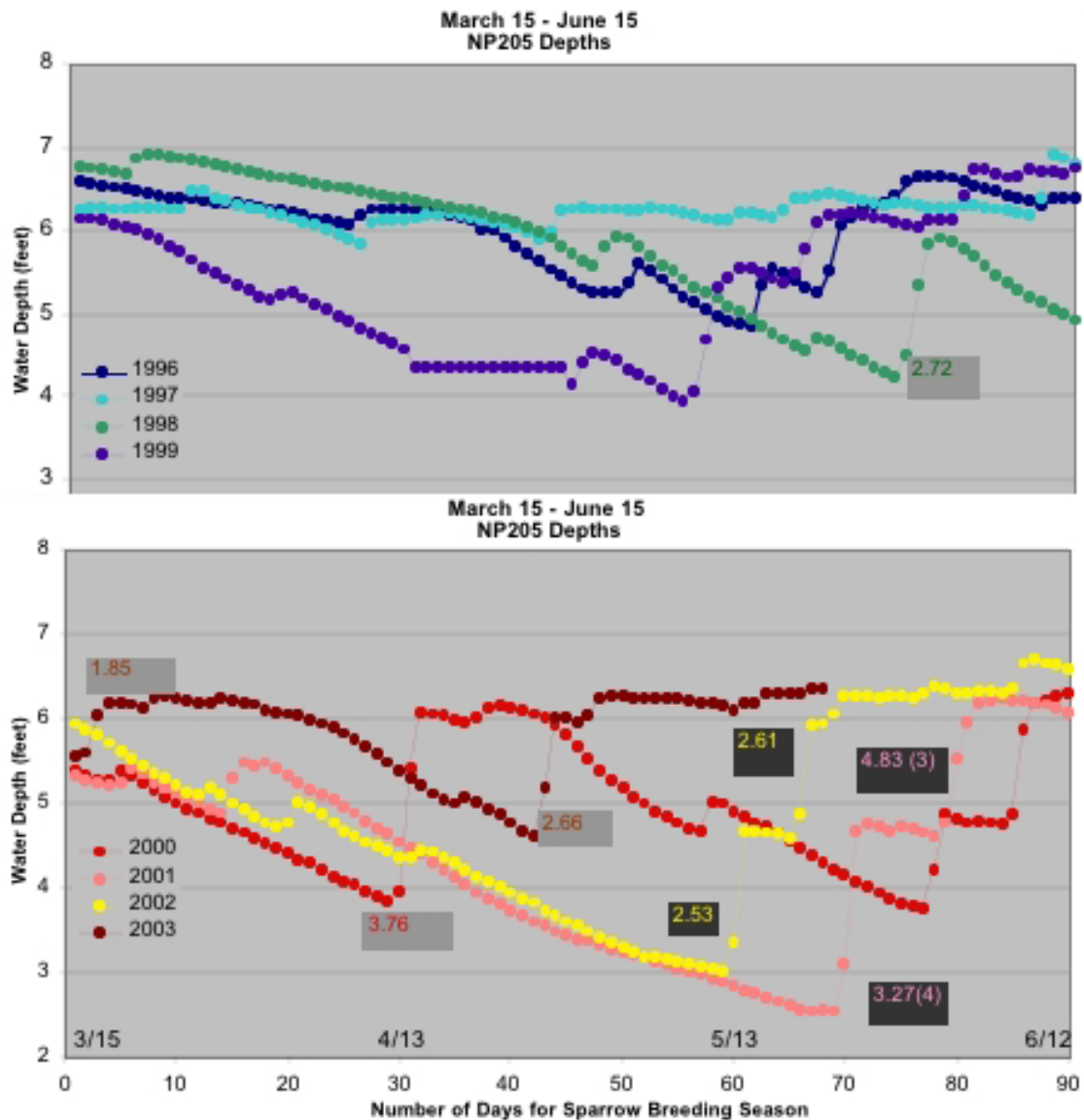


Figure 3. (a) Water levels at NP205 from 1996 to 1999 and (b) from 2000 to 2003 for the 90 days starting March 15<sup>th</sup> each year. Numbers in boxes show two-day rainfall totals, except when the rainfall events were distributed over longer than two days, when the duration, in days, is shown in parentheses. For further details see text.

In contrast, water levels in 2000 to 2003 were nearly always below 6 feet during these 90 days. Generally, water levels dropped at about one foot per 20 days. However, in most years, large rainfall events raised water levels dramatically during the breeding season. E.g. a mid-April rain (3.76 inches in two days) in 2002 raised water levels by over two ft, a late April rain (2.66 inches in two days) in 2003 raised water levels by one ft.

The event in 2000 (often called the “no-name” storm) was likely particularly damaging to the sparrow’s nesting. The breeding season started with relatively low water levels (below 6 feet at NP205), and the rain event raised water levels in the middle of the breeding season.

### 2.4.2 Estimating available habitat from water levels

To translate these water levels at NP205 into available habitat, Pimm et al. (2002) mapped how much of the area of population A is at a given elevation (Figure 4). Figure 5 summarizes this map quantitatively in terms of area and elevation. Approximately, 275 km<sup>2</sup> of this area is >5 ft, 175 km<sup>2</sup> > 6 ft, 75 km<sup>2</sup> >6.5 ft and none >7 ft. These areas are total areas; not all afford suitable habitat. Using a well-calibrated satellite-image based model of sparrow habitat that excludes areas that are too bushy for sparrows or too small to support sparrow territories, the amount of available habitat was estimated. Above 5 ft, approximately 125 km<sup>2</sup> of this area is suitable sparrow habitat in one or more years, 90 km<sup>2</sup> >6 ft, and 40 km<sup>2</sup> >6.5 ft.

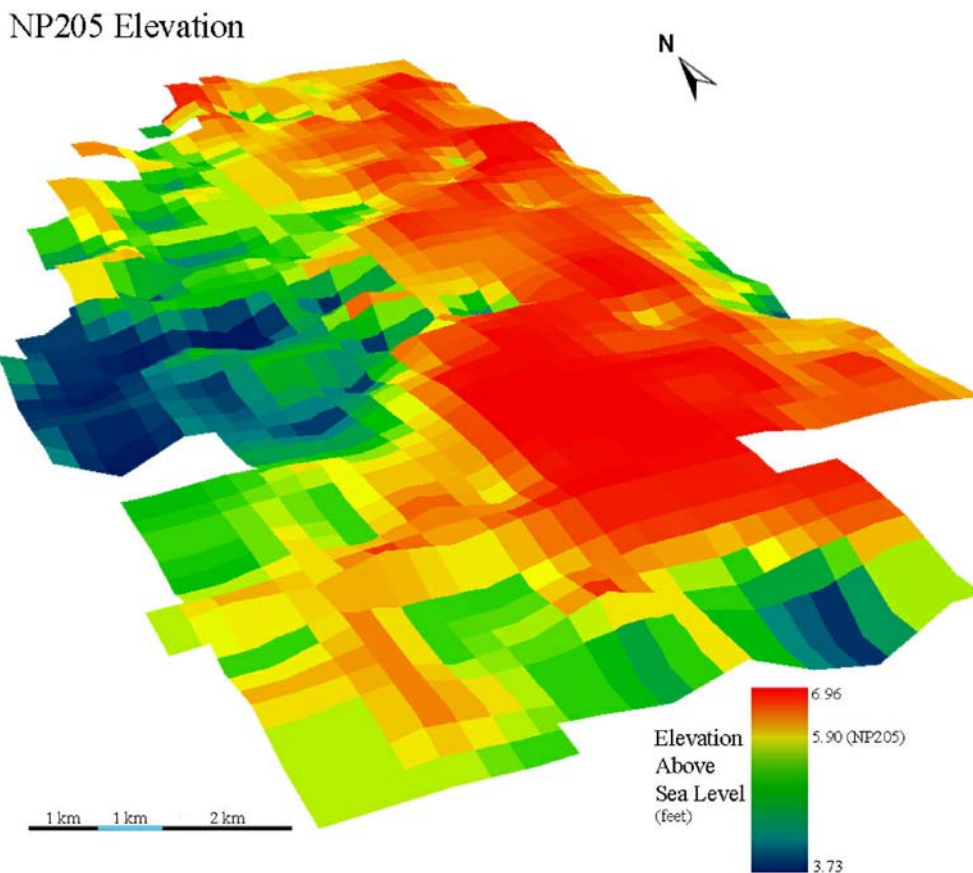


Figure 4. An elevation map of the area that encompasses population A.

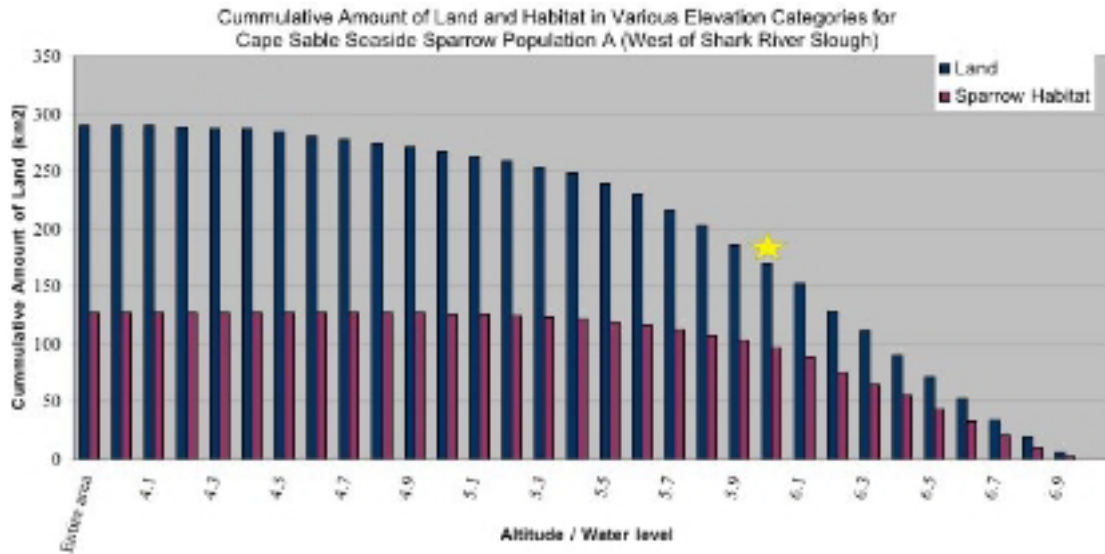


Figure 5 shows the areas in population A that are dry (“land”) and in habitat that is predicted to be suitable habitat in one or more years. Predicted habitat in any given year is likely to be no more than three-quarters of this latter area and the birds, at best, will be able to use only a fraction of this area (see text for details).

Even these numbers provide too optimistic a view of how much habitat might be available in each year. No species can be 100% efficient at occupying potential habitat. The reasons why the sparrows do not occupy all the possible area in every year are complex. They likely include some areas being wet in a particular year, being burned in the year or previous years, the sparrows being unable to colonize possible habitats because they are too small in area (or too isolated), or possibly that the sites are unsuitable for sparrows in every year for reasons not included in the habitat model.

For a given water depth in Figure 3, Figure 5 predicts how much habitat is predicted to be suitable in one or more years. Perhaps three-quarters of this area is suitable in a particular year, but not all is available throughout the breeding season. The word “available” is the key. To be able to produce one brood, the birds must have dry habitat for about 40 days continuously to complete a nesting cycle. (two broods require longer.) The heights of water at NP205 below which the water remained for about 40 continuous days in the breeding season, plus the estimates of potential available sparrow habitat (in km<sup>2</sup>) at that height are shown in Table 1.

Table 1.

Year	Height (ft)	Area (kn2)	Estimated Sparrow Numbers
1996	6.2	76	384
1997	6.3	66	272
1998	6.2	76	192
1999	5.4	122	400
2000	6.1	89	448
2001	4.5	128	128
2002	4.7	128	96
2003	6.2	76	128

Pimm and Bass (2003) emphasize that estimates of potential area are best viewed as comparative, since the area the sparrows can occupy will be substantially less. Clearly, the three years following the massive flooding of 1993 to 1995 were still not good for the sparrow breeding. In 1999, low water levels afforded larger dry areas for the birds to breed. The following year, the breeding season was likely interrupted by a mid-season storm that flooded large areas. The following two years were relatively dry, but 2003 looks as though it might be a very poor year for sparrow breeding.

### *2.4.3 Sparrow numbers*

Table 1 also shows the estimated number of sparrows in population A. Because of the small numbers of individuals actually counted, their interpretation requires care. The highest estimate (448) corresponds to the year after one of the best years for sparrow habitat (1999). Biologists expect that good breeding years would be apparent the following year. The mid-season flooding of 2000 likely severely harmed the population, so that despite the next two years being relatively dry, the population may have had trouble recovering. Figure 6 shows their distribution.

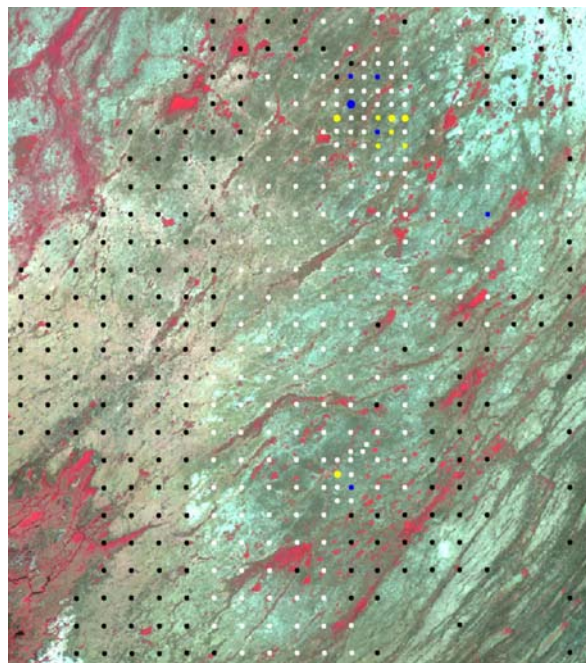


Figure 6. Counts of sparrows in 2003 in population A. Black dots are sites counted in others years, white dots sites counted in 2003, but not found to hold birds. Blue dots are sites holding one (small dot) or two (larger dots) on the regular survey. Yellow dots are comparable, but counted on a supplemental survey (see text).

In order to improve the confidence of the estimates of the now small population A, biologists conducted an additional survey in this area in 2003, using a 0.5km grid, rather than the more generally applied 1km grid (see Figure 6). The figure shows that the remaining birds are found in two concentrations, a larger one in the north, a smaller one in the south that closely match the areas of highest ground in Figure 4.

Pimm et al. (2002) estimate the potential for sparrow numbers to increase from one year to the next. In brief, they find that when the sparrow population (as a whole) can produce only one clutch per year, it likely cannot increase and will merely hold its own. Only when the population (as a whole) can produce two broods a year will the population increase. Figure 3 and the calculations derived from it show that only a small part of population A nest on sufficiently high ground that it can produce even one brood a year consistently, year after year. An even smaller part of population A is free from flooding for long enough to produce two broods a year and so have the potential to export birds to areas from which flooding has removed them in the past.

#### ***2.4.4 Summary for population A***

Conditions were improved considerably for sparrows in population A in 2000 onwards, though the population was almost certainly harmed by the mid-April rain event of that year. However, the area that remains dry during the breeding season is still very small compared with the extent of the sparrow's distribution in 1981 and 1992, when this population, population A, held almost half of the total sparrow population.

### **2.5 A comparison of the years 1996 through 1999 with the years 2000 to 2003. *The Eastern Populations (C-F)***

The work of Lockwood (in Pimm et al. 2002, and in preparation) determined that sparrow nesting is delayed by at least two years following fires. Fires are most frequent along the eastern boundary of the sparrow's range, likely a result of this area being simultaneously drier than it was historically and adjacent to areas outside the natural system subject to human use and abuse.

Populations C, D, and F are subject to frequent fires and part of population C, that near Taylor Slough Bridge has suffered altered hydrology that has made the habitat unsuitable. The small numbers of birds counted, as illustrated by the population estimates in Table 2, means that it would be difficult to detect any improvement in the habitat since the implementation of IOP. Population D, however, is cause for concern. Only two birds were counted in 2001 (for a population estimate of 32) and none since.

Table 2. Population estimates in three eastern populations.

POP	81	92	93	94	95	96	97	98	99	00	01	02	03
C	432	48	0		0	48	48	80	144	112	96	112	96
D	400	112	96		0	80	48	48	176	64	32	0	0
F	112	32	0		0		16	16	16	0	32	16	32

Three populations appear on these images (Figure 7): part of population B in the southwest, part of population C in the northwest, and population D in the southeast. The extent of yellow in population D in the 1998 image corresponds to an area the population



occupied from 1981 to that year. Notice that in 2000, a substantial part of this area was flooded to a line along a north-south canal and levee road. (It shows up as pale blue on the image.) Even to the east of the canal and levee road, little habitat is predicted as being suitable. The damage caused by this event persists through 2002, though it does seem that there is suitable habitat east of the canal. It seems likely that the flooding event of 2000 was responsible for the recent crash of population D.

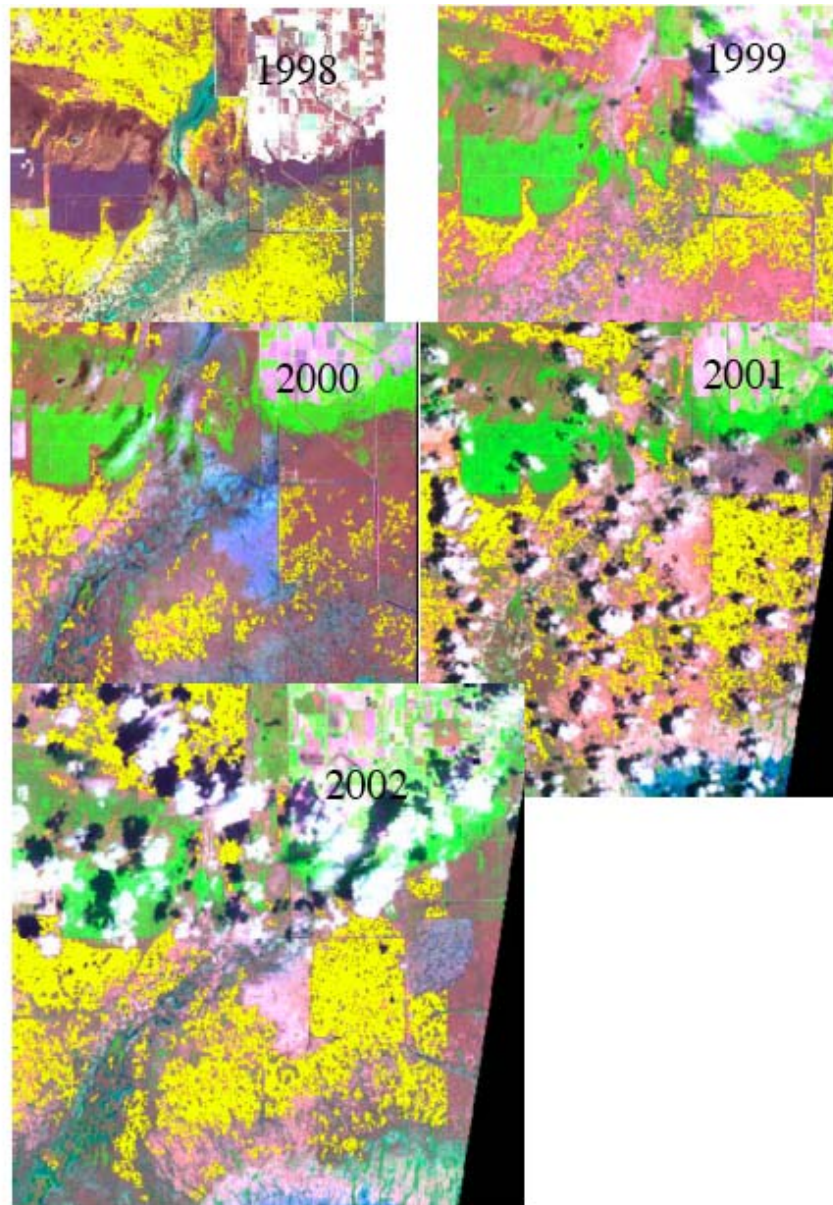


Figure 7 shows five satellite images of population D taken during the breeding season. (An image is not yet available for 2003). Green areas depict dense vegetation (except in 1998, where a different mix colors these red.) Water is blue throughout and dry prairies show up as pink. Dry areas that are classified as potential sparrow habitat by our computer model are shown in yellow. White areas in the northeast are agricultural fields and urban areas.

### 3. Cape Sable Seaside Sparrow Summary, Conclusions and Recommendations

1. The Cape Sable seaside sparrow occurs in six sub-populations. Two — A and D — are of immediate concern.
2. In Sub-population A, Water levels at NP205 from 1975 to 2003 show long-term trends, with dry years in the late 70s to early 80s, when breeding season water levels were often under 6 feet (the approximate height of NP205), followed by wetter years in the middle 80s. The late 80s to 1992 were usually dry, while the years from 1993 to 1995 were exceptionally wet, a condition exacerbated by unprecedented breeding season water-releases across the S12s. High water levels in 1993—1995 caused a precipitous decline in the number of sparrows.
3. The period of interest compares 1996 to 1999 (inclusive) to 2000 to 2003 (inclusive) and involves the 90 days following March 15<sup>th</sup> each year. Water levels at NP205 remained above 6 feet for all but about 20 days of 1996, all of 1997, and about 30 days in 1998 (ending with a 2 day rainfall total of 2.72in in late May). In contrast, in 1999, water levels were below 6 feet from March 15<sup>th</sup>, until mid-May,
4. In contrast, water levels in 2000 to 2003 were nearly always below 6 feet during these 90 days. Generally, water levels dropped at about one foot per 20 days. However, in most years, large rainfall events raised water levels dramatically during the breeding season. E.g. a mid-April rain (3.76in in two days) in 2002 raised water levels by over two ft, a late April rain (2.66in in two days) in 2003 raised water levels by one ft.
5. To translate these levels at NP205, we employ a map of how much of this area is at a given elevation. Approximately, 275 km<sup>2</sup> of this area is >5 ft, 175 km<sup>2</sup> > 6 ft, 75 km<sup>2</sup> >6.5 ft and none >7 ft. These areas are total areas; not all afford suitable habitat. Using a well-calibrated satellite-image based model of sparrow habitat that excludes areas that are too bushy for sparrows or too small to support sparrow territories, we estimate how much habitat is available. Approximately, 125 km<sup>2</sup> of this area is potential sparrow habitat >5 ft, 90 km<sup>2</sup> >6 ft, and 40 km<sup>2</sup> >6.5 ft. Only a fraction of these areas can be occupied in any year, but these numbers provide a relative basis for comparison.
6. In sum, conditions were improved considerably for the sparrows in population A in 2000 onwards, though the population was almost certainly harmed by the mid-April 2000 rain event. However, the area that remains dry during the breeding season is still very small compared with the extent of the sparrow's distribution in 1981 and 1992, when this population held almost half of the total sparrow population.



7. In population D, no birds were seen in 2002 and 2003. A fire burned a large part of what was once sparrow habitat in 2000, the same year that this area was flooded during the breeding season. A detailed analysis of water levels in this sub-population before and after IOP should be undertaken.
8. Overall, IOP seems to have benefited the sparrow population in A, the population most severely impacted by water management practices. The IOP may have harmed the sparrow population in D, and we do not have enough information to assess the impacts of the IOP on populations C, E, and F. Population B, as expected, has not been changed by the IOP.
9. Future work should continue to monitor all populations at the present levels of effort. In addition, populations A, D, and F should be surveyed on a finer scale (0.5km) each year. On the ground surveys of A and E should continue. In addition, on the ground surveys should search for birds in populations D and F.

#### **4. Recommendations for Threatened and Endangered Species Monitoring and Research**

##### **4.1 Cape Sable seaside sparrow**

Given the continued risks of flooding and frequent fires to which this bird is subject, it is essential that annual monitoring of all populations continue until the total number of birds has returned to its former levels. These activities comprise five separate efforts:

1. The annual helicopter survey should continue. In addition, it is clear that for the populations that are presently small (all but B and E), the helicopter should survey these populations on a half-kilometer grid (as was done for parts of population A in 2003), to obtain more precise estimates of numbers. This will likely require a 10% increase in the survey effort (and so cost) over the current budget.
2. Detailed site studies record nesting success and survival in populations A, B, and E. Each has a different emphasis. Work in B monitors the population that has maintained its original numbers. Future work should continue to assess this population in case there is any change in status. This can be done at present levels of funding.
3. Work in population A records the population that water levels have most severely effected. Detailed surveys show that the greatest remaining numbers of sparrows in population A are a few kilometers to the west of the present study area. Future work should expand the detailed studies in this area, but this can be done at present levels of funding.
4. Work in population E is lead by Prof. Lockwood and studies the effects of fires on sparrow numbers and nesting success. This should continue at present funding levels.

5. Analyses of remote sensing imagery assess the amount of available habitat each year. This work should expand to include long-term analyses of aerial photography to map fires and their possible effects on bushes in the eastern populations. In addition, this work will carefully monitor any changes in vegetation cover that follow from hydrological changes.

There is one additional activity.

6. Detailed studies should include visits to population F, to monitor its status as a baseline for anticipated improvements in this area.

Activity 1 is funded directly through Everglades National Park, though Pimm participates actively in the helicopter survey. Activity 4 is funded through a budget to Lockwood. All other activities are funded through a budget to Pimm that was \$98K in 2003. After inflation, the 2004 budget should be \$100K.

## 4.2 Snail Kite

Given the reported increases in water depths and hydroperiods that have occurred over the years in Water Conservation Area 3A (prime kite habitat) and the current declines in snail kite reproductive productivity and population (see highlight box), kite researchers Wiley Kitchens and Julian Martin, of the USGS FL Cooperative Fish and Wildlife Research Unit in Gainesville, propose the following add-ons to their current research efforts. The proposed activities will address current snail kite demography and

### Recent demographic results show alarming trends concerning the snail kite population in Florida

University of Florida snail kite researchers Dr. Wiley Kitchens and Julien Martin have found that kite abundance has drastically and steadily declined since 1999 (see Figure Box1). In 2003 the population was estimated to be half the size of the 1999 population. The reasons for this severe decline are still unclear, and one could easily speculate about potential causes such as West Nile virus, which was first reported in Florida in 2001. However, we should note that the number of nests and consequently the number of young fledged also exhibit negative trends. Again, we are not exactly sure what factors are actually limiting the reproductive ability of the kites. However, one can confidently assert that Lake Okeechobee, which from 1985 to 1995 was one of the more productive kite breeding sites, has been severely altered since then, to the point that almost no fledging has been produced out of this site since 1996. In addition, there has been a major drought in the study area (Water Year 2000/2001), lake enhancement (draw downs) and extensive aquatic weed control activities in the Kissimmee Chain of Lakes; and the implementation of the IOP in Water Conservation Area 3A (WCA3A).

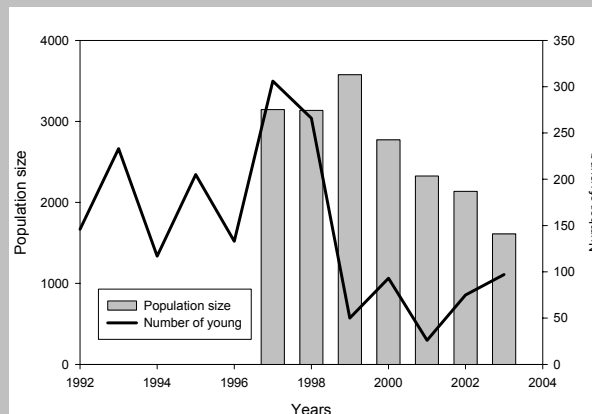


Figure Box1. Population size of Snail Kite in Florida and apparent number of young produced every years.

movement studies as well as the vegetative habitat structure of WCA3A. These studies are considered necessary for the evaluation of IOP effects on the endangered snail kite as well as the future evaluation of alternative water management scenarios.

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While the drought did temporarily affect adult survival (decreased by 17 percentage points), it is the decreased nesting activity and reproductive success that gives us special concern regarding the stemming of this decline to achieve a more sustainable population growth rate. In fact, unless these parameters are brought back to pre-1998 conditions, computer modeling (Population Viability Analysis) suggests the kite will go extinct.

Concerning WCA3A (which is the most productive snail kite breeding site), Kitchens and Bennetts (2002) have hypothesized that the maintenance of a prolonged hydroperiod (i.e. longer than under a natural regime) could negatively impact the foraging and breeding habitat used by the kites. In regards to this concern we have implemented intensive habitat and nest success studies in WCA3A in order to examine the long term response of vegetative habitats to the alleged longer hydro-periods and depth durations projected by the U.S. Army Corps of Engineers for the IOP. We have instrumented WCA3A with continuous water monitoring gauges in a spatial array based on kite nest activity that will provide the information critical to examining potential impacts of the IOP. We are unaware of any other instruments placed in the prime kite nesting areas.

In the interim, we are certainly not suggesting that the water elevation in WCA3A be drastically reduced during the peak of the breeding season (January to August). Our survival analysis showed that both adult survival and juvenile survival could be substantially affected by a moderate regional drought (Water Year 2000/2001), and that many birds might not be able to move to refugia even if refugia are available, if those refugia are too far apart. Furthermore our preliminary analysis showed that repeated droughts in the WCA, would have dramatic consequences on the kite population, possibly leading to a rapid extinction. We would however be supportive to a gradual reduction of water depths and hydroperiods , particularly in the western sector.

Natural drying of the habitat is most likely needed for the restoration of the plant communities that support the apple snails and constitutes the nesting substrates of the kites. However if possible water managers should attempt to manage areas, contiguous to the critical habitat, that could serve as refuges when such drastic event occurs.

This last point lead us to the issue concerning the draw down of Lake Tohopekaliga. Although we feel that a local draw down for certain units of the Kissimmee chain of lakes, if conducted appropriately (i.e.moderate draw down, no excessive use of herbicides, minimal scrapping), could help maintain good kite habitat, it is essential that during such drastic events that kites are left with refugia in close proximity allowing them to survive and breed. In the case of the Lake Tohopekaliga draw down, it is imperative that Lake Kissimmee is maintained at an appropriate elevation (to be determined) and that no treatment operations (mechanical harvesting or herbiciding) are conducted in the core breeding areas. We also feel that given the current status of the population the timing of this draw down should accommodate a window to allow for apple snail reproduction in the whole chain of lakes.

Finally we intend to avoid naïve correlative analyses between demographic parameters and water levels given the complexity of the system. Analyses of this type can lead to erroneous conclusions, and possibly detrimental management. Crude approaches are appropriate only when very limited data are available. We advocate a mechanistic approach that attempts to incorporate the complexity of the system. We feel that the combination of empirical studies and modeling efforts such as Everkite and data-rich Population Viability Analyses lead to better management decisions.

That stated, the reliability of Everkite, which is a spatially explicit individual based model, depends on the quality of the empirical data used in the model. We feel that currently many estimates need to be

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improved. In particular: local and regional movement estimates, recruitment, local survival, breeding propensity and age at first reproduction. It is also essential to better understand the connection between hydrology, plant communities and snail availability to the kites. These are the focus of the recommended snail kite monitoring and research activities discussed elsewhere in this document.

Source: The above essay is a summary of a discussion lead by Dr. Wiley Kitchens of the University of Florida at the Vero Beach Office of the U.S. Fish and Wildlife Service on 12 November 2003. Also cited are Kitchens and Bennetts (2002) (need full citation). Dr. Kitchens can be reached at [kitchensw@wec.ufl.edu](mailto:kitchensw@wec.ufl.edu)

Current snail kite monitoring is funded at approximately 80K a year from the Army Corps of Engineers. Kitchens and Martin had additional funds from the U.S. Fish and Wildlife Service for the past 3 years (2000, 2001, and 2002) specifically to look at drought effects but the project has lapsed. The kite project needs additional funds to continue the radio-monitoring and mark/re-sight studies. The habitat study to evaluate IOP impacts is scheduled for 3 more years and is about 120K per year. Both are grossly under-funded given the increased effort required to get a handle on both what may be going on with kite reproduction, recruitment and habitat. The upgrades for the habitat studies below are one-time requests. The monitoring of kite demography and movements is a continuing (3-4 year) recurring cost.

***4.2.1 Vegetative Habitat Study upgrades:***

1. The task of extrapolating long-term hydrologic trends from the 3 established gauges in WCA3A to the newly established spatial array of 20 new gauges established in 2002 requires an intense neural net modeling effort that will cost approximately 65K.
2. The GPS-based ground surveys required to provide a sufficiently resolute topographic base for a vegetation succession model would require 6 months and cost approximately 30K.

***4.2.2 Kite Demography and Movement Studies***

Over the years we have observed a general pattern of the primary nesting areas in WCA3A moving up the landscape-level elevation slope through time presumably as a response to degrading habitat quality resulting from increased water depths and hydroperiods over the past 30+ years. The following tasks are proposed as intensification of our current efforts to resolve any impacts to the kite from the IOP. We propose an increased effort (25%) in both the ENP and WCA3A resulting in additional funding of \$50K for the three items below.

1. Enhance monitoring activity of: a) nest abundance; b) nest success; c) nest locations (GPS coordinates); d) number of young produced per nest in WCA3A and ENP.
2. Continue mark/re-sighting methods of monitoring the snail kite population. Protocol would increase number of random transects in the park and WCA3A , so that we can: a) locate nests and mark the young produced out of those nests; b) have a representative sample of sighting of marked and unmarked individuals (for population estimation purposes). Both the quality of the data collected for nest monitoring and mark/re-sight methods, will depend on the extent of the area we will be able to access (i.e the further we will be able to move out of the designated airboat trails the more reliable and representative our sampling will be).
3. Enhance radio-telemetry studies as a complement to banding re-sighting. It allows us to: a) increase the precision of our demographic estimates (e.g. survival) and movement estimates; b) increase our power for inference when relating those parameters to environmental factors such as hydrology; c) because our radio telemetry protocol involves aircraft surveys, we can increase considerably the spatial extent of our study, it also enable us to discover new pockets of suitable habitats.

#### **4.3 Wading Birds (Wood Storks)**

These activities are designed to continue and enhance research and monitoring of populations of breeding and foraging wading birds in the south Florida ecosystem. Wading birds are a dominant predator in the region and represent a large part of the vertebrate biomass. Breeding bird responses especially are considered to be integrative and reflective of many aspects of the wetland habitat. These recommended activities are considered necessary for the evaluation of IOP effects on the Federally listed wood stork and other wading birds as well as the future evaluation of alternative water management scenarios.

1. Distribution and abundance of wading birds in the southern Everglades (Systematic Reconnaissance Flights – SRF). This is an ongoing endeavor funded by the South Florida Natural Resources Center (SFNRC) of Everglades National Park. Current cost is \$75K/yr.
2. Distribution and abundance of wading birds in Water Conservation Areas and Big Cypress National Preserve currently funded by the Army Corps of Engineers. This activity is proposed for future funding by the Monitoring Assessment Plan Project (MAP) through the Comprehensive Everglades Restoration Plan (CERP). Current cost is approximately \$200K/yr.
3. Analysis of pooled SRF data funded by the South Florida Water Management District (SFWMD). \$75K/yr. for 2 years. No additional funding needed.

4. Monitoring of colonial wading bird nesting in Everglades National Park (ENP). Ongoing activity funded by the SFNRC. \$5K/yr.
5. Determination of foraging locations of wading birds and relationship to food availability. Not currently funded. \$50K/yr. for 2 years.
6. Develop a statistical foraging-habitat model of sites used by wading birds. Not currently funded. \$50K/yr. for 2 years.
7. Analysis of Florida Bay water bird data and development of statistical foraging-habitat model. Not currently funded. \$50K/yr. for 2 years.

#### **4.4 American Crocodile**

In South Florida we have the unique opportunity to integrate endangered species conservation with ecosystem restoration and management. For the first time since its discovery in Florida the American crocodile is being studied throughout its range in the United States. American crocodiles thrive in healthy estuarine environments and in particular are dependent on freshwater deliveries. In this regard crocodiles can be used to evaluate restoration alternatives, and set success criteria for Florida and Biscayne Bays. Crocodiles also can be used as an indicator of negative impacts of freshwater diversion due to coastal development in Miami-Dade, Collier and Lee Counties.

Crocodiles are a performance measure for the RECOVER Monitoring and Assessment Plan. Specific performance measures that relate to the American crocodile include growth, and survival of juvenile crocodiles. Perhaps even more importantly, we have an opportunity to reevaluate the status of the American crocodile. This naturally provides an excellent opportunity to spotlight the success of an endangered species recovery effort. Continued research and monitoring will be an essential component of this effort. These studies are considered necessary for the evaluation of IOP effects on the endangered American crocodile as well as the future evaluation of alternative water management scenarios. Two projects are identified below:

1. Status, Distribution, and Habitat Relations of the American Crocodile in Florida - The objectives of this project are to determine relative abundance, distribution, habitat relations, nesting growth and survival of crocodiles in Florida, especially Everglades National Park and Florida Bay, and Biscayne National Park and Biscayne Bay. The cost of this ongoing effort is currently \$100K/yr. Partial funding (\$78K) is currently secure through September of 2004. Thus there is a \$22K shortfall for this years work. No funding commitments have been made beyond September of 2004.
2. Crocodile Habitat Suitability Modeling – Frank Mazzotti of the University of Florida has developed a crocodile habitat suitability model that can be used to

evaluate IOP effects on this endangered species as well as the effects of future alternative water management scenarios. The model requires appropriate predictive salinities as input. These will soon be available. The cost to prepare the model, run it, and interpret the output is \$25K. This activity is currently unfunded.

### **Assessing the effects of water management scenarios on the endangered American crocodile**

The American crocodile (*Crocodylus acutus*) is a primarily coastal crocodilian that occurs in parts of Mexico, Central and South America, the Caribbean, and at the northern end of its range in southern Florida. As for other species of crocodilians, hunting, for hides, meat, collections, and out of fear, and habitat loss (direct and/or due to degradation) have made the American crocodile endangered throughout its range. In Florida, habitat loss, due to development required to support a rapidly growing human population along coastal areas of Palm Beach, Broward, Dade, and Monroe Counties has been the primary factor in endangering the United States population. This loss of habitat principally affected the nesting range of crocodiles, restricting nesting to a small area of northeastern Florida Bay and northern Key Largo by the early 1970's (Ogden 1978; Kushlan and Mazzotti 1989). At that time most of the remaining crocodiles (about 75% of known nests) were in Florida Bay in Everglades National Park.

When crocodiles were declared endangered in 1975 (Federal Register 40:44149) scant data were available for making informed management decisions. Field and laboratory data that were available suggested that low nest success, combined with high hatchling mortality, provided a dim prognosis for survival (Evans and Ellis 1977, Ogden 1978). Results of an intensive studies conducted by the National Park Service, Florida Game and Fresh Water Fish Commission, and Florida Power and Light Company resulted in a more optimistic outlook for crocodiles in Florida (Mazzotti 1983; Moler 1991). Largely based on results of these studies and recovery efforts by the US Fish and Wildlife Service, the National Park Service established a crocodile sanctuary in northeastern Florida Bay in 1980, Crocodile Lakes National Wildlife Refuge was created, and Florida Power and Light Company began a long term management and monitoring program.

Currently, new issues face crocodiles in Florida. Florida Bay has undergone a number of changes that have caused a great deal of concern for the ecological health of this ecosystem. Efforts have been, and continue to be, made to improve Florida Bay and Biscayne Bay. Monitoring and research studies have continued on crocodiles with the dual purposes of assessing the status of the population and evaluating ecosystem restoration efforts. An important aspect of evaluating ecosystem restoration efforts has been increasing our understanding of hydrological relations of crocodiles (Mazzotti and Brandt 1995).

American crocodiles thrive in healthy estuarine environments and in particular are dependent on freshwater deliveries (Mazzotti 1999). In this regard, crocodiles can be used to evaluate restoration alternatives, assess water management scenarios such as the IOP, and set success criteria for Florida and Biscayne Bays. Crocodiles also can be used as an indicator of negative impacts of freshwater diversion due to coastal development in Dade, Collier and Lee Counties. Continued research and monitoring will be an essential component of this effort. Crocodiles are a performance measure for the RECOVER Monitoring and Assessment Plan. Specific performance measures that relate to the American crocodile include growth, and survival of juvenile crocodiles.

Water management practices have changed the natural patterns of freshwater inflow to Florida Bay. Taylor Slough was a major source of freshwater for central and northeastern Florida Bay. During the wet season, freshwater would pool behind a series of marl and sand berms along the north shore of the Bay. Restricted by berms, freshwater would flow into northeastern Florida Bay through Taylor Slough

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and into the central Bay primarily through McCormick Creek. Potentially large amounts of water would continue to flow into the Bay during the dry season.

This historical, early to mid dry season flow from Taylor Slough coupled with rainfall could have provided saline conditions suitable for hatchling growth. Historical flow patterns probably also pushed

## 5. Cape Sable Seaside Sparrow Notes and References

Pimm et al. (2002) is a compilation of studies, most of which have been published elsewhere. It should be quoted as:

Pimm, S. L., J.L. Lockwood, C. N. Jenkins, J. L. Curnutt, M. P. Nott, R. D. Powell and O. L. Bass, Jr. 2002. *Sparrow in the grass: a report on the first 10 years of research on the Cape Sable Seaside Sparrow*. Printed for Everglades National Park, 182.pp.

And is available from

<http://www.env.duke.edu/faculty/pimm/csshtml/10yearreport.html>

- Chapter 1 was written by John Curnutt; it is an original work.
- Chapter 2 was written by Julie Lockwood. Parts of this have been published as Lockwood, J. L., K. H. Fenn, J. L. Curnutt, D. Rosenthal, K. L. Balent, and A. L. Mayer. 1997. Life history of the endangered Cape Sable Seaside Sparrow. *Wilson Bulletin* 109:234–237.
- Chapter 3 was written by Julie Lockwood. Parts of this have been published as Lockwood, J. L., K. H. Fenn, J. M. Caudill, D. Okines, O. L. Bass, Jr., J. R. Duncan, and S. L. Pimm. 2001. The implications of Cape Sable Seaside Sparrow demography for Everglades restoration. *Animal Conservation* 4:275–281.
- Chapter 4 was written by Julie Lockwood.
- Chapter 5 was written by Stuart Pimm.
- Chapter 6 was written by Stuart Pimm and Julie Lockwood. Parts of this chapter have appeared in three publications: Curnutt, J. L., A. L. Mayer, T.M. Brooks, L. Manne, O. L. Bass, Jr., D. M. Fleming, M. P. Nott, and S. L. Pimm. 1998. Population dynamics of the endangered Cape Sable Seaside-Sparrow. *Animal Conservation* 1:11–20.
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- Chapter 7 was written by Clinton Jenkins and others and was published as



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- Chapter 8 was written by Stuart Pimm and Oron Bass Jr. Most of this text appears as Pimm, S. L., and O. L. Bass, Jr. 2002. Range-wide risks to large populations: the Cape Sable Sparrow as a case history. Pp. 406–424 in S. Beissinger and D. R. McCullough (eds.), Population viability analysis. University of Chicago Press, Chicago.

#### **Citations from Crocodile text box**

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